

## THE GOLDEN NEMATODE ON POTATOES

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The golden nematode (also referred to as the potato root eelworm and the potato cyst-nematode) is so-called because of the characteristic golden brown color of its cysts.

Heterodera rostochiensis Wollenweber 1923, is the scientific name that is widely known for the golden nematode. However, in recent years taxonomists have assigned it to the separate genus Globodera Skarbilovich 1959, and subdivided it into two separate species, G. pallida Stone 1953, and G. rostochiensis Wollenweber 1923.

The golden nematode has been referred to as the most important pathogen of potatoes. One researcher found that potato losses ran as high as one ton per acre (2.24 metric tons per hectare) for every 20 eggs per gram of soil. The annual world potato crop has been estimated to be 50 million acres (112 million hectares) or 300 million metric tons. The golden nematode first appeared on the North American continent in a potato field on Long Island, New York, in 1941. It has since then remained a threat to the potato industry of the United States.

This nematode is thought to have originated in the Andes Mountains of South America, where it is believed to have evolved along with its principal host, the cultivated potato. It is reported to have been introduced into Europe during the middle or second half of the 19th Century on potatoes which were imported for breeding. Since its introduction into Europe it has spread to other potato growing areas around the world and has been reported from as many as 40 countries including the United States and Canada.

**BRIEF DESCRIPTION:** The golden nematodes are obligate parasites which live in the soil and feed upon the roots and underground stems of vascular plants. The female body which will later become a cyst is very nearly spherical in shape and is smaller than the head of a pin (approximately 0.5-0.75 mm). The neck protrudes about 0.01 mm. Small cysts formed later in the season do not develop as fully and are more elongate and pear-shaped. The stylet is 0.024-0.026 mm long. Eggs within the cyst number 50-600 and have a length to breadth ratio of 2:1. Mature males are about 1 mm long. Larvae are 0.045-0.046 mm long.

**HOSTS:** The host range of the golden nematode is relatively narrow. The principal economic crops affected are potato, tomato, and eggplant. In addition, a small number of cruciferous plants and solanaceous weeds is included.

**SYMPTOMS:** Because the golden nematode does not cause immediate aboveground symptoms on infected plants, it can go undetected for years. Potato fields can suffer a 15% loss of production without showing any aboveground symptoms of infection. The severity of symptoms will vary with the population density of the nematode. The first symptom of infestation is poor growth in one or more spots in a potato field. These isolated patches will enlarge each year that potatoes are grown on the same field. Plants may be off-color, stunted, appear unhealthy, and wilt readily during the hot, dry part of the day. Tubers are smaller rather than fewer, and root development is poor. It has been observed that lateral roots are decreased more than main roots. Tuber yield is further reduced by early senescence of the plant.

**PATHOLOGY:** In a field which is already infested at planting time, the roots are invaded before the shoots emerge. Infective second stage larvae cut through the cell walls and enter the root leaving a trail of ruptured cells. The larvae may move through the root away from the tip. They settle in the root with heads toward the stele and feed from cells in the pericycle, cortex, or endodermis. Saliva from the esophageal glands is injected into the root cells where the nematode head is embedded. It is believed that these secretions from the nematode cause the cells around the head area to coalesce and form what are called giant cells or syncytia. These enlarged cells become a permanent feeding reservoir and are necessary for the continued development of the nematode. This activity within the host root results in water stress and disturbance of nutrient transport for the developing plant.

**LIFE CYCLE & BIOLOGY:** The life cycle begins with the second stage larvae freshly emerged from eggs inside the cyst. Newly emerged larvae are attracted to the rhizosphere of the plant and enter the roots near the tips or at the sites of new lateral roots. The larvae begin feeding inside the roots. The sex of the adults is environmentally determined by the amount of nutrition

available. If there are few nematodes and the food supply is abundant, the population will be predominately female. If there is a heavy infestation of nematodes and the food supply is limited, the population will be predominately male.

As the nematodes mature, the female body swells and ruptures the root cells and protrudes outside. The head and neck remain buried inside the root while the remainder of the body is outside the root. The mature males leave the root and fertilize the sedentary females. Males have a short life of about 10 days and do not feed during that time.

After the female dies, the spherical body cuticle undergoes a process of chemical change, called tanning, and becomes very hard and tough. This is the cyst. Inside the cyst there may be 50-600 viable embryonated eggs. Inside the cyst, the eggs are resistant to desiccation and chemicals. The eggs, thus protected, overwinter in the cyst and can remain viable normally for 7 to 10 years. Survival for 20 and 30 years has been reported.

Hatching is stimulated by a substance secreted from the growing roots of the host plant; however, all the eggs do not hatch in one season. Some, for reasons we do not know, may remain quiescent and not hatch for an undetermined number of seasons. Sixty to 80 percent of the eggs in a cyst will hatch the first year, and the same percentage of the remaining eggs will continue to hatch each year thereafter. Some eggs will hatch without the presence of a host. In temperate climates populations have been reported to decline 30% per year when no host is present.

CONTROL: Efforts to control the golden nematode are hampered by the physical toughness, resistance, and longevity of the cyst and its ease of dispersal. Further difficulties are encountered by the fact that at least 8 nematode pathotypes complicate efforts to develop resistant potato varieties.

The mechanism of resistance now available in selected potato varieties interrupts the life cycle by preventing the female nematode from developing normally. In some instances the formation of giant cells, which are necessary for normal development of the female nematode, is inhibited. In other instances there is necrosis of the cells surrounding the head of the female. Nematode numbers have been reported to decrease 75-80% per year when resistant varieties of potatoes are grown.

Another method of control utilizes the principle of disease escape. Potatoes with a shorter growth period restrict population build-up of nematodes. Also early planting varieties in colder climates can get a good start while the soil is too cold for nematode development. Yearly crops of these potatoes are possible because they can be harvested before the nematodes mature.

Crop rotation is valuable when used with other methods of control. By itself a rotation of 4-5 years between host and nonhost crops is necessary to produce one healthy potato crop.

Many different chemical controls have been investigated. However, if acceptable nematicides are used along with other methods of control, populations of the golden nematode can usually be suppressed below economic threshold levels.

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